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Engineering as a Liberal Art: Taking a Broad View*

By H. Vincent Poor, Princeton University

Engineering education is sometimes characterized as being rigorous but not as broad as a traditional liberal arts education. As Leah Jamieson of Purdue University eloquently explains, the best education for engineers is certainly rigorous but is in no way narrow. In fact, the strength of this nation's technological enterprise -- and hence its overall competitiveness -- demands engineers who combine technical knowledge with creativity, teamwork and a broad understanding of the society in which they work.

Perhaps even less accurate is the notion that engineering education is only for engineers. Today no one should consider her or himself to be well-educated without knowing something about science and technology -- not specialized knowledge, but a basic familiarity with principles and a recognition that science and technology flow throughout our culture, even dominating many aspects of our lives. At its best, engineering stands at the intersection of science and society, applying the power of mathematics, physics, chemistry and (increasingly) biology in the service of society. That exciting vantage point means that we, as engineering educators, have a unique opportunity and responsibility to engage students outside the sciences and engineering. By making our profession's goal of serving society manifest in our teaching, we can contribute an important component to all of education.

It is useful to step back for a moment and look at the larger picture of universities and their role in society. The role of educational institutions -- which has been more or less constant since classical times -- has been to engage the next generation, to bring them along intellectually and to help them move into leadership positions. Of course, times change and the subject matter that we teach certainly changes. Today more than ever, any leader must be comfortable thinking about scientific and technological subjects: What are the basic principles behind current developments? How have technology and society shaped each other at key moments through history?

At Princeton, although my colleagues and I on the engineering faculty spend most of our time teaching engineering students, more than 60 percent of the University's students outside the engineering school take at least one engineering course. This includes students majoring in philosophy and classics, economics and public policy – essentially all majors. These students recognize the need to know something about technology regardless of what career they think they might pursue in the future. We would like to bring that percentage closer to 100. Even more ambitiously, we would like for each student to take more than one engineering course during their four years, ideally one a year.

How can we push toward those numbers? Here I think carrots work better than sticks, because mandatory distribution requirements can only go so far in generating student interest. At Princeton, all students are required to satisfy requirements for "quantitative reasoning" and "science and technology," but those requirements can be met in a variety of ways and do not, by themselves, guarantee the kind of intellectual engagement for which we are aiming. Besides, we are really doing our job only when students take our courses because they want to, not because they have to.

A key to engaging students is to make sure courses are relevant to real issues in students' lives. Professor Robert Socolow, one of our experts on climate change, teaches "Energy for a Greenhouse-Constrained World" in which students receive an inside look at technical issues that are at the forefront of today's public policy agenda. A course I developed, "The Wireless Revolution," led students through the technical, social, political and economic issues arising in the field of wireless communications during the very years when cell phone use overtook landline traffic. For students curious about the world around them, these courses are a natural draw, and they illustrate the fundamental role of technology in a context that makes the lessons stick.

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Such courses require both institutional and national support. Universities should create incentives for faculty members to put their ideas into action when they conceive of interesting subject matter. They also must find ways to sustain such courses when their originators move on to other projects. Princeton created its Center for Innovation in Engineering Education to support existing courses that have broad appeal and to encourage new ones. The center also serves as a focal point for publicizing such courses, which tend to get lost in individual departmental course lists, so that undergraduates can easily see their choices and know that the University values the courses.

The National Academy of Engineering is increasingly providing support to educational initiatives, including ones that reach beyond conventional engineering students. In 2005, the NAE selected Princeton's David Billington for its Walter Robb Engineering Education Senior Fellowship, which allowed him to improve and expand the instructional materials for his popular course, "Engineering in the Modern World." That course explores how engineering and its products -- from automobiles to computers -- have influenced society and how political and cultural forces have affected engineering. I believe that this kind of support at the national level is critical to advancing technological literacy.

Drawing non-engineers to our courses also benefits engineering students. Engineering schools everywhere are increasingly aware of the need to instill their students with an understanding of teamwork and how to work across disciplines. In business, government or any real-world situation outside the academy, engineers must collaborate with non-engineers. Some of the courses that have been most successful at drawing a broad participation are ones that create teams of engineers and non-engineers, and the benefits accrue in both directions.

At Purdue University, Leah Jamieson and Ed Coyle created Engineering Projects in Community Service (EPICS), a course series that brings students from various backgrounds together to solve problems in their local communities. Since they founded EPICS in 1995, the course has been adopted at 17 other universities, including Princeton where Ed Coyle is currently a visiting professor. Also at Princeton, a course in our electrical engineering department, "High-Tech Entrepreneurship," brings together students with technical and non-technical backgrounds to learn about venture-backed enterprises and to create business plans, several of which have resulted in new businesses post graduation.

That brings me back to my general point about universities and leadership. At Princeton, we view our undergraduate engineering education as part of a liberal arts curriculum, even for those majoring in engineering. The philosophy behind this view is that what we are really teaching undergraduate engineers is analytical thinking and problem solving. They are learning, of course, domain-specific knowledge about a particular branch of engineering. But we realize that the real professional training for an engineer is at the graduate level or on the job in these days of specialization. At the undergraduate level, we are really teaching students a way of thinking, a way of looking at problems that goes beyond engineering as a discipline. If they want to practice engineering these are important skills, but these are also important skills for anyone who expects to lead others in making a positive difference in the world.

When I meet young students, I assure them that, contrary to stereotypes, engineering is one of the most exciting areas for anyone who wants to engage with others in solving real problems, to lead and to serve society. As engineering educators, we must take a broad view of our teaching and use our unique perspective to give full expression to that promise.

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Dr. Poor has been an advocate for the widespread teaching of the technical, economic, political and social aspects of technology to academically diverse audiences. He was the founding director of Princeton's Center for Innovation in Engineering Education, which has the fostering of such pedagogy as one of its primary goals. Dr. Poor is a member of the National Academy of Engineering and is a Fellow of the American Academy of Arts and Sciences and the IEEE. Recent recognition of his work includes a Guggenheim Fellowship and the IEEE Education Medal. He served as HKN's Xi chapter vice president in 1972.